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Loyola University

DEPARTMENT
of
ENGINEERING

FUND A.D. MCMIX

BULLETIN
1912-1913

Address: The Registrar or the Dean
Hayes Avenue and Sheridan Road, Chicago, Illinois
Telephone Rogers Park 37

CALENDAR

First Semester, 1912-13.

1912.	
Sept. 11-14	Entrance and conditional examinations.
Sept. 16-17	Registration days.
Sept. 18	Instruction begun.
Oct. 12	Columbus Day. (Holiday.)
Nov. 27	Thanksgiving recess begun.
Dec. 23	Christmas vacation begins.
1913.	
Jan. 3	Instruction resumed.
Jan. 28-30	Final examinations of First Semester.

Second Semester, 1913-14.

Jan. 31	Registration day.
Feb. 3	Instruction begun.
Feb. 22	Washington's Birthday. (Holiday.)
March 20	Easter recess begun.
March 24	Instruction resumed.
May 28	Final examinations begun.
May 30	Memorial Day. (Holiday.)
June 2-28	Field work in Surveying.
June 21	Commencement.

First Semester, 1913-14.

1913.	
Sept. 10-13	Entrance and conditional examinations.
Sept. 15-16	Registration days.
Sept. 17	Instruction begun.
Oct. 12	Columbus Day. (Holiday.)
Nov. 26	Thanksgiving recess begun.
Dec. 23	Christmas vacation begins.

Officers and Faculty

John L. Mathery, S. J., President of the University.
Henry S. Spalding, S. J., Regent.
James Dynan Newton, A. M., M. E., Dean.
Albert Esterman, S. J., Treasurer.

James Dynan Newton, A. M., M. E., Dean. Professor of Civil Engineering.
Anton Adolph Neff, M. E., Assistant Professor of Mechanical Engineering.
James Guerin, A. B., B. S., Assistant Professor of Drawing.
John K. Moore, A. M., Lecturer on Construction.
Michael Joseph Milmoe, M. E., Lecturer on Machine Design.
Paul V. Hyland, Lecturer on Architecture and Building Construction.
Louis J. A. Rockett, A. B., Assistant in Descriptive Geometry and Plane Surveying.
Henry S. Spalding, S. J., Professor of English.
Edward J. Gleason, S. J., Professor of Logic and Philosophy.
William Agnew, S. J., Professor of Physics.
Theodore Schulte, S. J., Professor of Chemistry.
Louis J. Puhl, S. J., Associate Professor of Chemistry.
Thomas A. Kelly, S. J., Professor of Mathematics.
Frederic Siedenburg, S. J., Professor of Economics.
Augustine M. Effinger, S. J., Professor of German.
John B. DeShryver, S. J., Professor of Romance Languages.

SPECIAL LECTURERS.

Among those who will deliver special lectures on subjects of general and professional interest are the following:

Lieutenant John I. Bryan, U. S. R. C. S., Chief Engineer, U. S. S. Tuscarora.
William H. Cahill, A. M., C. E., Director Hebrew Institute, Chicago, Ill.
G. A. M. Liliencrantz, C. E., Assistant Engineer, U. S. Engineer Department, Chicago, Ill.
Ernest McCullough, C. E., Consulting Engineer, Chicago, Ill.
Arnold D. McMahon, A. M,. L. L. B., Secretary and Professor, Loyola University Law School.
William Stetson Merrill, A. M., Chief Cataloger, Newberry Library, Chicago, Ill.
G. Leo Pleins, Consulting Sanitary Engineer, Chicago, Ill.
Major Edgar Russell, U. S. A., Commandant, Signal Corps School, Fort Leavenworth Kansas.
A. S. R. Smith, M. E., General Traffic Supervisor, Chicago Telephone Co.

REQUIREMENTS FOR ADMISSION.

Candidates for admission to the College of Engineering must be at least sixteen years of age, must present satisfactory testimonial of good moral character, and must be qualified in fifteen units of entrance subjects as enumerated below.

Note.—A unit represents the equivalent of five prepared recitations a week for one scholastic year in a single subject.

The prescribed units are:

English	3 units.
History	1 unit.
Elementary Algebra	1 unit.
Advanced Algebra	½ unit.
Plane Geometry	1 unit.
Solid Geometry	½ unit.
Elementary Physics	1 unit.
Total	8 units.

Electives sufficient to make up the required fifteen units may be offered from the following list:

Latin	2 to 4 units.
Greek	1 to 3 units.
German	2 to 3 units.
French	2 to 3 units.
English	1 to 2 units.
History	1 to 2 units.
Higher Algebra	½ unit.
Plane Trigonometry	½ unit.
Elementary Chemistry	1 unit.
Biological Science	1 to 2 units.
Manual Training	2 units.

Admission may be secured in one of the following ways:

1. By Examination.—Entrance examinations will be held at the university in June and September. See Calendar.

2. By Certificate.—Graduates from standard high schools or other approved preparatory schools will be admitted on presentation of official certificates exhibiting the number of merits to which the applicant is entitled in each subject of the preparatory course pursued.

3. From Other Colleges.—Students from other institutions, whose entrance requirements and courses are substantially equivalent to those of Loyola University, will, upon presenting proper certificates of good standing and honorable dismissal, be admitted to advanced standing without examination and be given credit for the work done in such institutions.

4. As Special Students.—Persons over 19 years of age, not candidates for degrees, will be admitted as special students, provided they give evidence of preparation for the subjects desired. Such students may become candidates for degrees by passing the examinations prescribed for entrance.

FEES AND EXPENSES.

Matriculation fee	$ 5.00
Tuition	100.00
Diploma fee	10.00
Engineering laboratories, per credit, per semester	2.50
Physical and chemical laboratories, per credit, per semester	2.50
Surveying, field work, per semester	3.00
Summer course in surveying, 2 weeks	12.50
Summer course in surveying, 4 weeks	25.00
Breakage deposit, (Chemistry)	10.00

The matriculation fee is paid only once. The tuition fee is payable in two installments: $50.00 on October 1st and $50.00 on February 1st; ten days of grace are allowed. At the end of that time non-payment debars from classes.

No rebate is allowed on tuition paid, but when a student is forced, for valid reasons, to withdraw from college, the balance of the tuition representing that part of the semester for which he is absent may be redeemed in any other department studies within one year from date of withdrawal from the college.

Any balance remaining at the end of each year from the deposit requierd to defray the expense of breakage in the chemical laboratories, will be refunded or credited for the succeeding year at the option of the student.

The college provides no dormitory system for students. Board and rooms may be obtained in the vicinity of the college at reasonable rates.

Further information may be obtained from the Registrar, or the Dean of the College of Engineering.

THE COURSES OF STUDY.

The outlines of the courses which follow, and the formulation of their requirements, rest on the well founded theory that successful endeavor in any field of engineering activity depends primarily on thorough theoretical and practical training in the fundamental sciences on which modern engineering practice is based. To give such training as may lead to future usefulness on the part of its students, and to develop in them the power to attack and solve new engineering and scientific problems, is the purpose of the instruction offered in the College of Engineering. The work, therefore, in all the courses outlined, is mostly prescribed, and, because of the correlation and interdependence of the professions for which training is provided, a large proportion of the studies—modified in form and extent to meet the general requirements of the individual courses—are taken in common by all students.

Contemporary engineering practice has assumed many phases of specialization within the rather comprehensive fields of civil, mechanical, electrical, and chemical engineering in the general acceptation of the terms. No one may hope to become expert in more than a very few of the various lines classified under one or another of these broad divisions. Though specialized practice is the order of the day, it is very generally recognized that extreme latitude in the election of special technical studies, in connection with the courses offered, is not conducive to sound engineering education, and tends to defeat the real purpose of engineering training. There are therefore included as elective only a comparativly small number of such special technical subjects as are admittedly valuable in affording desirable general scientific training and promoting immediate average efficiency along broad lines of professional activity.

Note: Courses in Sanitary and Architectural Engineering are in preparation.

Considerable importance is attached to English, German, French, Logic, and Economics, which are included as prescribed studies and designed to accord with the other work of the courses. The requirement in English will not be considered satisfied by the completion of the work of the first year. Instruction will be resumed and continued for as long a period as may seem necessary in the case of any student who shows subsequent inability to express himself clearly, accurately, and effectively.

Frequent visits of inspection, according to prearranged schedule under the guidance of instructors, will be made to convenient manufacturing and industrial establishments, power plants, public works, the sites of important pieces of construction, and other points affording opportunities for stimulating the student's interest and increasing his knowledge. Such visits, besides familiarizing him in a general way with the significance of productive and constructive engineering and lending themselves to his acquirement of exact habits of observation, will afford a basis for written work in which rhetorical and technical instruction may be advantageously combined.

In line with the foregoing, the work in all the courses is identical during the first year, and there is little divergence during the second year. The student is thus afforded an opportunity for self-adjustment, and the danger of premature choice of profession, which is a factor to be reckoned with, is decreased; but he will have become habituated to the scientific methods of thought and procedure so important in the prosecution of his further studies. In the third year the differentiation between the courses is more specific, and in connection with the comparatively advanced and more highly specialized work of the fourth year there is permitted the election of one of a number of groups of studies bearing on some specialty closely related to the course hitherto pursued. All such elections presuppose thorough qualifying preparation, and are subject to the approval of the Dean. The major emphasis, however, is laid on the prescribed studies in all the courses, not only as contributory and essential to professional success, but as desirable elements in culture and in life.

Outline of Courses

FRESHMEN YEAR—COMMON TO ALL COURSES.

	First Semester.	Second Semester.
English	3	3
Logic	2	0
German or French	4	4
Chemistry	3	3
Drawing and Descriptive Geometry	3	3
Advanced Algebra	3	0
Trigonometry	3	0
Analytic Geometry	0	5
Elementary Surveying	0	3
	21	21

Surveying .... 2 weeks.
Shop work .... 8 weeks.

CIVIL ENGINEERING

SOPHOMORE YEAR.

Physics	5	5
Calculus	5	3
Differential Equations	0	2
Analytical Chemistry	3	0
Drawing	3	2
Geology	3	0
Economics	2	0
Advanced Surveying	0	4
Technical Mechanics	0	5
	21	21

Topographic Surveying .... 4 weeks.
Shop or field work .... 6 weeks.

JUNIOR YEAR.

Mechanics of Materials	5	0
Hydraulics	0	5
Materials Laboratory	2	2
Hydraulic Laboratory	0	1
Descriptive Astronomy	3	0
Geodesy	0	3
Roofs and Bridges	5	4
Railway Engineering	4	4
Roads and Pavements	2	0
Economics	0	2
	21	21

Railway Surveying (optional) .... 4 weeks.
Shop, field, or office work .... 5 or 10 weeks.

SENIOR YEAR.

	First Semester.	Second Semester.
Bridge Design	3	0
Water Supply	3	0
Sewerage	3	0
Heat-Power Machinery	3	0
Electrical Machinery	0	3
Mechanical and Electrical Laboratory	1	1
Reinforced Concrete	0	5
Masonry and Foundations	0	2
Engineering Problems	0	2
Economics	3	0
Contracts and Specifications	0	3
Elective	5	5
	21	21

MECHANICAL AND ELECTRICAL ENGINEERING

SOPHOMORE YEAR.

Physics	5	5
Calculus	5	3
Differential Equations	0	2
Analytical Chemistry	3	0
Machine Drawing	3	0
Geology	3	0
Economics	2	0
Kinematics	0	6
Technical Mechanics	0	5
	21	21

Shop work .... 10 weeks.

JUNIOR YEAR.

Mechanics of Materials	5	0
Hydraulics	0	5
Materials Laboratory	2	1
Hydraulic Laboratory	0	1
Physical Laboratory	2	2
Heat-Power Engineering	3	3
Mechanical Laboratory	1	1
Electrical Machinery	3	3
Machine Design	5	3
Economics	0	2
	21	21

Shop work ....10 weeks.

SENIOR YEAR. (MECHANICAL.)

	First Semester.	Second Semester.
Power Plant Design	3	3
Steam Machinery Design	3	0
Gas Machinery Design	0	3
Designing and Drawing	3	3
Mechanical Laboratory	3	3
Electrical Laboratory	3	0
Economics	3	0
Contracts and Specifications	0	3
Elective	3	6
	21	21

SENIOR YEAR. (ELECTRICAL.)

Power Plant Design	3	3
Electrical Engineering	6	6
Mechanical Laboratory	3	0
Electrical Laboratory	3	3
Economics	3	0
Contracts and Specifications	0	3
Elective	3	6
	21	21

CHEMICAL ENGINEERING

SOPHOMORE YEAR.

Physics	5	5
Calculus	5	3
Differential Equations	0	2
Qualitative and Quantitative Chemistry	3	3
Drawing	3	0
Geology	3	0
Economics	2	0
Kinematics	0	3
Technical Mechanics	0	5
	21	21

Shop work ....10 weeks.

JUNIOR YEAR.

Mechanics of Materials	3	0
Hydraulics	0	3
Materials Laboratory	2	1
Hydraulic Laboratory	0	1
Physical Laboratory	2	2

Quantitative Analysis	5	0
Organic Chemistry	5	5
Heat-Power Engineering	3	3
Mechanical Laboratory	1	1
Gas and Oil Analysis	0	3
Economics	0	2
	21	21

Shop or Laboratory work........................10 weeks.

SENIOR YEAR.

Industrial Chemistry	5	5
Physical Chemistry	2	2
Electro-Chemistry	2	2
Electrical Machinery	3	3
Economics	3	0
Contracts and Specifications	0	3
Elective	6	6
	21	21

DESCRIPTION OF COURSES.

ENGLISH.

The object of the instruction is to enable the student to express himself clearly, concisely, accurately, and vigorously, special stress being laid on those parts of rhetoric which will be of greatest value to engineering students. The written exercises are designed to accord with the other work of the courses. Students are instructed in the use of the library collections.

1. A course in rhetorical theory and practice, with essays based on the lives of distinguished scientists and visits of inspection.

Freshman; 1st semester; 3 credits.

2. A continuation of course 1, with essays based on assigned technical readings and visits of inspection.

Freshmen; 2nd semester; 3 credits.

3. A conditional course supplementing the work of 1 and 2, and consisting wholly of theme work and consultation.

Required only of students who show inability to write clear and correct English. It will be continued until a satisfactory degree of proficiency is attained.

FRENCH AND GERMAN.

All students are required to take one year of work in either French or German. Elementary and advanced courses will be offered in each and the student may elect either. For outlines and descriptions of these courses see Bulletin of the College of Arts and Sciences.

MATHEMATICS.

1. Advanced Algebra.—A brief review of the foundations with graphic representation and of the theory and use of logarithms, followed by a treatment of permutations and combinations, theory of limits, series, undetermined coefficients, determinants, theory of equations, complex numbers.

Freshman; 1st semester; 3 credits.

2. Trigonometry.—The trigonometric functions and their relations; proofs of the principal formulas of plane trigonometry; proofs of formulas and solution of all cases of right and oblique plane triangles; computation of areas.

Proofs of principal formulas of spherical trigonometry; formulas and solutions for right and oblique spherical triangles.

Freshman; 1st semester; 3 credits.

Numerous pependent problems and applications.

3. Analytic Geometry.—Graphic representation; the straight line; conic sections; higher plane curves; the essentials of Solid Analytic Geometry. Considerable problem work is required.

Freshman; 2nd semester; 5 credits.

4. Differential and Integral Calculus.—The direct and inverse operations are carried on in parallel. The fundamental formulas and methods of differentiating and integrating are followed by a geometric treatment of maxima and minima; applications to curves, surfaces, and volumes are considered. Taylor's Theorem and the subject of series in general will be treated in the second semester, together with the applications of the calculus to the engineering sciences. Some attention will be given to the subjects of Hyperbolic and Elliptic functions. Considerable problem work is exacted.

Sophomore; 1st semester, 5 credits; 2nd semester, 3 credits.

5. Differential Equations.—The purpose of the course, which is supplementary to course 4, is to familiarize the student with the types of equations ordinarily encountered in the study of the engineering sciences, and to indicate the principles and methods employed in their solution. The solution of numerous problems will be made a leading feature of this course.

Sophomore; 2nd semester, on completion of course 4; 2 credits.

ASTRONOMY.

1. Descriptive Astronomy.—A study of the fundamental facts and principles of the subject, with observatory practice.

Junior; 1st semester; 3 credits.

GEOLOGY.

1. General Geology.—A presentation of the general principles of geology and their practical applications. The course will be arranged with special reference to the needs of engineering students. Occasional excursions will replace laboratory practice. Three lectures and one laboratory period per week.

Sophomore; 1st semester; 3 credits.

ECONOMICS.

1. Elements of Economics.—A general survey of economic theory and a discussion of present-day economic problems including

wages, rent, interest, currency, banking, taxation, tariff, trusts, trades-unionism, socialism. Lectures and classroom discussions.

Sophomore; 2nd semester; 2 credits.

2. Organization and Management.—A study of American industries and a discussion of the methods of organizing, financing, and managing modern commercial institutions. The purpose of the course is to acquaint the student with the application of the general principles of economics to business life. Lectures, discussions, and field work.

Junior; 1st semester; 3 credits.

PHILOSOPHY.

1. Logic.—Formal logic or dialectics; definition, material and formal elements, kinds of reasoning, how to build an argument, analytic and synthetic methods. Material logic: truth, its nature and kinds, certitude, skepticism, cognoscitive faculties, authority, etc.

Freshman; 1st semester; 2 credits.

2. Psychology and Ethics.—Nature and properties of the human soul, cognoscitive faculties, intellect, will, liberty. General ethics, human action, morality, form of human action, divine and human laws. Applied ethics, rights and duties, right of property, socialism, society, law, etc.

PHYSICS.

1. General Physics.—A general course in the subjects of Mechanics and Heat; Light and Sound; Electricity and Magnetism. The methods of the calculus are employed to a considerable degree. Two lecture-demonstrations two recitations, and two laboratory periods per week.

Sophomore; throughout the year; 5 credits per semester.

2. Physical Measurements.—A laboratory course, supplemented by twelve lectures on the theory and methods of precise thermal and electrical measurements, involving quantitative work in the use of various instruments of precision, and the determination of physical constants. A report of specified form is required on each experiment.

Junior; throughout the year; 2 credits per semester.

3. Practical Photography.—The principles and processes of dry plate photography, including lectures on photographic optics and laboratory work in the exposure and development of dry plates; printing processes, copying, enlarging, and the making of lantern slides.

Elective; second semester; 2 credits.

DRAWING AND DESCRIPTIVE GEOMETRY.

NOTE.—The freshman work in drawing and descriptive geometry is given as a combined course, but, in the cases of special students or of those admitted to advanced standing, separate courses may be given as follows:

1. ELEMENTS OF DRAWING.—Freehand lettering; sketching and dimensioning; geometrical construction; orthographic projection and isometric drawing; working drawings, including conventions, standards, etc.; tracing and reproductive processes. Notes and lectures on drafting room methods.
Freshmen; 1st semester; 3 credits.

2. DESCRIPTIVE GEOMETRY.—The descriptive geometry of points, lines, planes, surfaces, and solids. Tangencies, intersections, and developments. Shades and shadows and the principles of linear perspective. One lecture or recitation and two drafting periods a week.
Freshmen; 2nd semester; 3 credits.

MECHANICS AND HYDRAULICS.

1. TECHNICAL MECHANICS.—The principles of Statics, Kinematics, and Kinetics, with technical applications. Analytic and graphic methods are used concurrently in the solution of problems.
Sophomore; 2nd semester; 5 credits.

2. MECHANICS OF MATERIALS.—A study of the more important materials of construction, their manufacture, properties, and structural uses, and the theory of resistance to stress and deformation with applications to engineering design. Lectures and recitations.
Junior; 1st semester; 5 credits.

2a. MECHANICS OF MATERIALS.—A briefer course than 2; arranged to meet the requirements in Chemical Engineering.
Junior; 1st semester; 3 credits.

3. ADVANCED MECHANICS.—An advanced course supplementary to 2, and devoted to the treatment of such special topics as dynamical stability, the mathematical theory of elasticity, internal work and its derivatives, the theorem of least work, linear arches and curved beams. Lectures, problems, and applications.
Senior elective; 1st semester; 3 credits.

4. MATERIALS LABORATORY.—The laboratory practice will be adapted to the requirements of the individual courses and will include the various standard tests of the more important materials of construction. The work will be supplemented by lectures on the technique

of testing, collateral reading, and reports carefully prepared according to a prescribed form.

Junior; throughout the year; 2 credits per semester.

4a. Materials Laboratory.—An advanced laboratory course, in continuation of the work of 4, devoted to testing and special investigations of materials of construction. Hours and nature of experimental work to be assigned in conference with the instructors concerned.

Senior elective; 1 to 3 credits per semester.

5. Hydraulics.—The theory of fluid pressure and equilibrium; the flow of water through orifices, weirs, tubes, pipes and channels, the theory of hydraulic measurements; hydraulic motors and machinery; naval hydromechanics. Lectures and recitations.

Junior; 2nd semester; 5 credits.

5a. A briefer course than 5, adapted to meet the requirement in Chemical Engineering.

Junior; 2nd semester; 3 credits.

6. Hydraulic Laboratory.—An experimental course to accompany 5, including logarithmic plotting, experiments with weirs orifices, pipes, meters and nozzles; the testing of hydraulic machinery.

Junior; 2nd semester; 1 credit.

6a. Hydraulic Laboratory.—An advanced course in experimental hydraulics, including capacity and efficiency tests of hydraulic machinery. The hours of work will be by appointment, and some latitude will be allowed as to the nature of the experimentation.

Senior elective; either semester; 1 to 3 credits.

CIVIL ENGINEERING.

1. Elementary Surveying.—Lectures, recitations, field and office work covering the principles, uses, and adjustments of the engineer's level and transit, and the uses of the steel tape; topographic surveying with transit and stadia.

Freshmen; 2nd semester; 3 credits.

2. Advanced Surveying.—The application of the foundamental operations to city, land, mine, and hydrographic surveying; the use of the plane table and sextant; precise leveling and triangulation, including the measurement of base lines and angles; the determination of azimuth by solar observation. Lectures, recitations, field and office work.

Sophomore; 2nd semester; 4 credits.

3. GEODESY.—The principles of practical astronomy and their application in the determination of latitude, longitude, time, and azimuth with the engineer's transit and sextant. Methods of conducting geodetic surveys, and the application of the method of least squares to the adjustment of observations. The figure of the earth.

Junior; 2nd semester; 3 credits.

4. SUMMER SURVEYING.—The summer courses in surveying are given at the close of the school year in June and are of a practical nature. The student will spend ten hours a day in the field or office in the performance of the various duties incident to the work of the surveyor. The courses in Elementary and Topographic Surveying are prescribed. The course in Railway Surveying and Location is optional. The periods allotted to these courses are two weeks for Elementary Surveying, and four weeks each for Topographic and Railway Surveying.

5. TOPOGRAPHIC DRAWING.—The conventional methods of representing topography and the platting of the results of surveys.

Sophomore; 2nd semester; 2 credits.

6. CONSTRUCTION DRAWING.—Stereotomy, dams, piers, arches, trestles, culverts, etc. Applications of Descriptive Geometry to engineering construction.

Sophomore; 1st semester; 3 credits.

7. RAILWAY ENGINEERING.—Lectures, recitations, field, and office work dealing with the subjects of railway location and construction. The theory of simple, compound, and transition curves, cross-overs, frogs and switches, turnouts, etc. Cross sectioning, the computation of cut, fill and haul; road bed construction, including ballast, track, culverts, trestles, etc. Estimates and costs.

The economics of location embracing a treatment of such topics as train resistance, the influence of grade, curvature, rise and fall; rolling stock and motive power; yards, stations, and terminals; street railways.

Junior; throughout the year; 4 credits per semester.

8. RAILWAY ENGINEERING.—A continuation of course 7, including a discussion of the economics of construction, a study of organization and management, maintenance of way, etc.

Senior elective; throughout the year; 2 credits per semester.

9. RAILWAY DESIGNS.—A conference and drawing room course in the proportioning of culverts and waterways, and the design of track layouts, yards, terminals, bridge masonry, and other railway structures.

Senior elective; 2nd semester; 3 credits.

10. Roads and Pavements.—The location, construction, and maintenance of roads, and the construction and maintenance of city streets and pavements, combined with a study of the materials used. Lectures, recitations, and collateral reading; visits of inspection and reports.

Junior; 1st semester; 2 credits.

11. Roofs and Bridges.—The analytic and graphic investigation of stresses in framed structures under various conditions of loading. Structural details. The design of a metal roof truss and of a plate girder, including general and detail drawings, bills of material, weights, and costs.

Junior; throughout the year; 1st semester; 5 credits; 2nd semester, 4 credits.

12. Bridge Design.—A continuation of course 11, involving the drafting room application of its principles to the design of simple riveted and pin-connected truss spans, following the practice of leading bridge companies.

Senior; 1st semester; 3 credits.

13. Higher Structures.—A study of continuous, cantilever, suspension, and arch bridges; statically indeterminate structures. Lectures, computations, and drafting room work.

Senior elective; throughout the year; 3 credits per semester.

14. Steel Buildings.—The principles of construction of mill and high steel-skeleton buildings; computation of stresses and design.

Senior elective; either semester; 2 credits.

15. Reinforced Concrete.—The theory and design of beams, slabs, columns, retaining walls, dams, and other structures, and a critical study of the design and structural features of reinforced concrete arch types. The course is concluded by the complete design, including drawings, of a reinforced concrete arch.

Senior; 2nd semester; 5 credits.

16. Masonry and Foundations.—The course is given by lectures, recitations, collateral reading, and visits of inspection. Among the subjects treated are the materials of masonry; the construction of bridge piers, abutments, dams, retaining walls, etc.; ordinary, pile, and subaqueous foundations.

Senior; 2nd semester; 2 credits.

17. Water Supply.—The collection, purification, and distribution of water supplies for domestic and other purposes.

Senior; 1st semester; 3 credits.

18. Sewerage.—The collection, treatment, and disposal of sewage. Lectures, recitations, and inspection trips.
Senior; 2nd semester; 3 credits.

19. Sanitary Engineering.—A continuation of 18 and 19, the work being devoted principally to problems and designing related to water supply, sewer systems, and sewage disposal plants.
Senior elective; 2nd semester; 5 credits.

20. Hydraulic Engineering.—The application of hydraulic theory and principles to the investigation and development of water power; irrigation, river and harbor improvement; drainage and canalization. The design of hydraulic works, plants, and appliances.
Senior elective; throughout the year; 3 credits per semester.

21. Engineering Problems.—The application of fundamental principles to the investigation and solution of practical problems.
Senior; 2nd semester; 2 credits.

22. Contracts and Specifications.—The elements of business law and a survey of the law of contracts as applied to engineering work. A study of general and special clauses used in the various kinds of engineering specifications. Practice in the preparation of contracts and specifications.
Senior; 2nd semester; 3 credits.

MECHANICAL ENGINEERING.

1. Machine Drawing.—A continuation of Drawings 1 and 2, and the application of their principles to machine drawing and empirical design. Sketching and detailing machine elements from model and copy; the making and use of standard data sheets; detail assembly drawings of complete machines. The work is designed to familiarize the student with commercial drafting room practice, and is of distinctly vocational character.
Sophomore; 1st semester; 3 credits.

2. Kinematics of Machinery.—Lectures and recitations on the theory of mechanisms, instant centers, cams, gears, linkage, velocity and acceleration diagrams, etc.
Sophomore; 2nd semester; 3 credits.

3. Kinematic Drawing.—The graphic application of the principles of course 2. A series of separate problems of graded complexity will be assigned to each student.
Sophomore; 2nd semester; 3 credits.

3a. Kinematics.—A combined lecture, recitation, and drafting room course briefer than 2 and 3, and arranged to satisfy the require-

ment in the principles of mechanism for chemical engineering students.
Sophomore; 2nd semester; 3 credits.

4. Lectures, recitation, and drafting room exercises covering the application of the principles of Drawing, Kinematics, and Mechanics to the proportioning of machine elements and the design of complete machines.
Junior; throughout the year: 1st semester, 5 credits; 2nd semester, 3 credits.

5. Heat-Power Engineering.—Lectures and recitations on the thermodynamics of gases and vapors as applied to heat engines; a study of fuels and the principles of combustion; boilers, engines, and auxiliaries. The indicator diagram. A detailed analysis of efficiencies and economies of various types of steam engines, gas engines, and turbines; valves and valve gears.
Junior; throughout the year; 3 credits per semester.

5a. Heat-Power Machinery.—A lecture and recitation course for civil engineering students, designed to impart a general knowledge of the structural features and operating characteristics of boilers and producers, steam and gas engines and auxiliaries, pumping, hoisting, traction, and other machinery. The course is devoid of much technical detail.
Senior; 1st semester; 3 credits.

6. Mechanical Laboratory.—Introductory experimental work in the testing and calibration of gauges, indicators, integrating instruments, etc.; power measurements; fuel and gas analysis; oil testing; the determination of engine efficiencies and the testing of auxiliary apparatus.
Junior; throughout the year; 1 credit per semester.

6a. Mechanical Laboratory.—A continuation of course 6, the work including the testing and determination of efficiencies of steam engines, boilers, gas and oil engines, pumps, air compressors, refrigerating machinery, etc.
Senior; throughout the year; 3 credits per semester.

6b. Mechanical Laboratory.—An advanced experimental course open only to students who have completed the prescribed laboratory courses. Hours and nature of the work to be arranged.
Elective; either semester; 1 to 3 credits.

Note.—The work in experimental engineering is varied according to the courses. Each experiment will be followed by a carefully prepared report of specified form.

7. Power Plant Design.—A continuation of course 5. Lectures, recitations, and computations dealing with the types and principles of boilers; multiple expansion engines, and their auxiliaries and dependencies; gas engines; steam turbines, refrigerating machinery, and air compressors. The selection of elements and their combination in power plants.

Senior; throughout the year; 3 credits per semester.

8. Steam Machinery Design.—A study of types and proportions of steam engines; the indicator card; entropy—temperature and crank effort diagrams; the design of such details as valve gears, governors, and fly-wheels; the balancing of engines.

Senior; 1st semester; 3 credits.

9. Gas Machinery Design.—A study of modern gas engines and producers, and the designing of important details of internal combustion engines.

Senior; 2nd semester; 3 credits.

10. Designing and Drawing.—A drafting room course paralleling the work of 8 and 9. This course must be accompanied, or preceded by 8 and 9.

Senior; throughout the year; 3 credits per semester.

11. Steam Boilers.—A study of steam boiler types, fuels, and furnaces; steam boiler computations, and the design of boiler details and accessories.

Senior elective; 1st semester; 3 credits.

12. Steam Turbines.—A general discussion of the types, principles, and economic and structural features of steam turbines; steam turbine calculations.

Senior elective; 2nd semester; 3 credits.

13. Compressed Air.—A study of the properties of air, the principles of air compressors, and the applications of compressed air.

Elective; 2nd semester; 2 credits.

14. Heating and Ventilation.—The fundamental principles of the subject, and their application to the design, construction, and installation of heating and ventilating systems.

Senior elective; 2nd semester; 2 credits.

15. Mechanical Refrigeration.—A study of the principles and methods involved in the artificial production of low temperatures, and a survey of the design, construction, and operation of refrigerating machinery and refrigerating systems.

Senior elective; 2nd semester; 2 credits.

ELECTRICAL ENGINEERING.

1. Electrical Machinery.—Lectures, recitations, and laboratory work dealing with the history of the subject, and the laws and properties of electric and magnetic circuits; electrical measurements; the theory construction and operation of direct and alternating current machinery.

Junior; throughout the year; 3 credits per semester.

1a. Electrical Machinery.—A briefer course than 1, arranged to meet the needs of civil engineering students.

Senior; 2nd semester; 3 credits.

2. Electrical Engineering.—Lectures, recitations, and computations on the theory and characteristics of electrical machinery, dealing in detail with the laws and properties of electric and magnetic circuits; direct and alternating current phenomena; transmission lines; generators, motors, transformers, converters, etc.

Senior; throughout the year; 6 credits per semester.

3. Electrical Laboratory.—Practice in the electrical laboratories will be continuous throughout the junior and senior years. The work will be of such nature as to meet the requirements of the individual courses. Opportunities for laboratory work of an advanced character will be afforded to those who have completed the prescribed courses. The regular work will include the testing of instruments, generators, motors, transformers, converters, storage batteries, etc.; it will be supplemented by occasional lectures. A carefully prepared report on each experiment is required.

Throughout the year; junior, 1 credit per semester; senior, 3 credits per semester.

4. Telephone Engineering.—The theory and operation of telephonic apparatus and the application of the principles of electrical engineering to the design, construction, and maintenance of transmission lines, and to the investigation of problems in telephone engineering.

Senior elective; 1st semester; 3 credits.

5. Electric Railways.—The application of the principles of electrical engineering to the construction, operation, and equipment of various types of electric railway systems. The dynamics of train movement, and the plotting of speed-time curves, railway load curves, etc.; location and financing; cost of construction and operation.

Senior elective; 2nd semester; 3 credits.

6. Transmission and Distribution of Electric Energy.—A discussion of typical systems of power generation, transmission, and distribution for lighting, traction, and industrial purposes, and their de-

sign, construction, operation, and maintenance with some reference to costs and rates.

Senior elective; 2nd semester; 3 credits.

7. Design of Electrical Machinery.—The applications of fundamental principles and of considerations of commercial practice to the design of various classes of direct and alternating current machinery.

Senior elective; 2nd semester; 3 credits.

8. Illumination and Photometry.—The theory of illumination and a discussion of illuminating apparatus and devices; the design, construction, and operation of electric lighting systems and the photometry of lamps.

Senior elective; 2nd semester; 3 credits.

CHEMISTRY AND CHEMICAL ENGINEERING.

1. General Chemistry.—Entrance Chemistry, if offered, will not be accepted as the equivalent of this course.

Two lecture-demonstrations, one recitation, and one laboratory period, covering the fundamental principles of the science, the chemistry of the non-metals and metals, and the elements of qualitative chemical analysis.

Freshmen; throughout the year; 3 credits.

2. Qualitative Analysis.—The laboratory work will be varied to some extent according to the course pursued and will include analyses of alloys, rocks, minerals, slags, mattes, and other compounds or mixtures. One lecture or recitation and three laboratory periods per week.

Sophomore; 2nd semester; 3 credits.

3. Quantitative Analysis.—An introductory course consisting of one lecture and three laboratory periods per week devoted to volumetric and gravimetric determinations, including practice in the calibration of flasks and burettes, acidimetry and alkalimetry, chlorimetry, and the analysis of simple compounds and ores.

Sophomore; 2nd semester; 3 credits.

4. Quantitative Analysis.—A continuation of course 3, and of a more advanced nature. Instruction will be given gravimetric, volumetric, and electrolytic methods of analysis. The work will include the analysis of iron and steel, slags, silivates, paints, lubricants, ores, etc. One lecture, laboratory conferences and the equivalent of five laboratory periods weekly.

Junior; 1st semester; 5 credits.

5. Gas and Oil Analysis.—A laboratory course with weekly conferences, devoted to practice in the calorimetry and typical methods of analysis of gases and oils.

Junior; 2nd semester; 3 credits.

6. Water Analysis.—Lectures and laboratory practice in the examination of water with reference to its use for domestic and industrial purposes.

Elective; 1st semester; 3 credits.

7. Organic Chemistry.—Two lectures and one recitation on the general principles and theories of organic chemistry and the methods of preparation and characteristic reactions of organic compounds with a corresponding laboratory course of three periods per week. A limited amount of work along special lines of organic chemistry may be elected.

Junior; throughout the year; 5 credits.

8. Advanced Organic Chemistry.—A conference and laboratory course dealing with the preparation and reactions of special classes of organic compounds and including ultimate organic analysis. The work may be varied, in a limited degree, according to the option of the student.

Senior elective; throughout the year; 3 to 4 credits per semester.

9. Industrial Chemistry.—The course is given by means of lectures, recitations, laboratory practice, and visits of inspection, and deals with the chemical processes, apparatus, and operations involved in various chemical industries, and with the analysis of raw materials and products. Attention is given, as far as may be, to estimates of apparatus and plants for particular purposes and to costs and management.

Senior; throughout the year; 5 credits per semester.

10. Physical Chemistry.—The course is arranged to embrace a systematic presentation, with experimental illustration, of the more important principles of theoretical chemistry, stress being laid on such points as the theory of solution, reaction velocity, catalysis, chemical equilibrium, and the applications of the principles of physical chemistry to industrial practice. The course is accompanied by laboratory work in the determination of molecular weights and physico-chemical measurements.

Senior; throughout the year; 2 credits per semester.

11. Electro-Chemistry.—Lectures, recitations, and laboratory work partly in continuation of course 11, dealing with the principles of the subject and their application to chemical industries. The labora-

tory practice includes electro-chemical measurements and the electrolysis of chemical compounds.

Senior; throughout the year; 2 credits per semester.

12. MICROCHEMISTRY.—Lectures and laboratory work on the use of the microscope and its accessories, and the application of microscopic apparatus and methods to chemical investigation and analysis.

Senior elective; 2nd semester; 3 credits.

13. ASSAYING.—Lectures and laboratory work in the crushing, sampling, and assaying of gold, silver, copper, lead, and zinc ores, and the sampling and assaying of bullion.

Elective; 1st semester; 3 credits.

14. METALLURGY OF IRON AND STEEL.—A discussion of the properties and principles of production and manufacture of iron and steel, with laboratory practice in special analytical methods applicable to iron and steel determinations. The work is supplemented by visits of inspection and reports.

Senior; 1st semester; 2 or 3 credits.

15. GENERAL METALLURGY.—A course treating of metallurgical processes and the principles of combustion and thermochemistry, pyrometry, fuels, fluxes, refractories, furnaces and artificial draft and blast.

Senior elective; 1st semester; 2 credits.

16. METALLURGICAL PROBLEMS.—The solution of a number of selected problems relating to the principles utilized in practical metallurgy.

Senior elective; 1st semester; 1 to 2 credits.

17. METALLURGY OF NON-FERROUS METALS.—A course of lectures dealing in considerable detail with the metallurgy of copper, lead, silver, gold, zinc, and aluminum, and more briefly with nickel, cobalt, arsenic, antimony, tin, mercury, bismuth, etc. The physical and chemical properties of ores and the various processes employed and principles involved in reduction and refinement are discussed.

Senior elective; 2nd semester; 3 credits.

18. METALLURGICAL LABORATORY.—The laboratory practice is closely related to the class room exercises. It includes special analytical methods applicable to iron and steel, fuel, fluxes, and slags. Practice in pyrometry and the measurement of blast velocity, and the analysis of flue gas by special apparatus. Roasting, smelting, leaching, and amalgamating processes as applied to the reduction of the ores of gold, silver, copper and lead.

Senior; 2nd semester; 3 to 5 credits.

19. CHEMICAL ENGINEERING.—A study of the types of apparatus and operations involved in chemical manufacture, the design of chemical plants, and the consideration of the chemical resistance of materials suitable for their construction.

Senior elective; 2nd semester; 3 to 5 credits.

EXAMINATIONS.

Examinations are held semi-annually at the end of each semester. The work done during the semester, as well as the examinations, is considered in the grading of students. The results of the examinations are expressed on the basis of 100.

70 is required for passing; 60-70 indicates a condition; below 60 shows failure. Regularity of attendance at lectures and laboratory, and faithfulness in the performance of daily work are of as much weight in determining the standing of students in their classes as are the examinations.

Conditions.—Conditioned students must remove such conditions at the examinations given for that purpose during the following semester. Failing in this the student is obliged to discontinue the subject in which he is conditioned and to repeat it during the next semester.

For a special examination of this kind a fee of $1.00 is charged.

DEGREES.

The degree of Bachelor of Science in Civil Engineering, Mechanical Engineering, Electrical Engineering, and Chemical Engineering will be conferred on students who satisfactorily complete the corresponding courses.

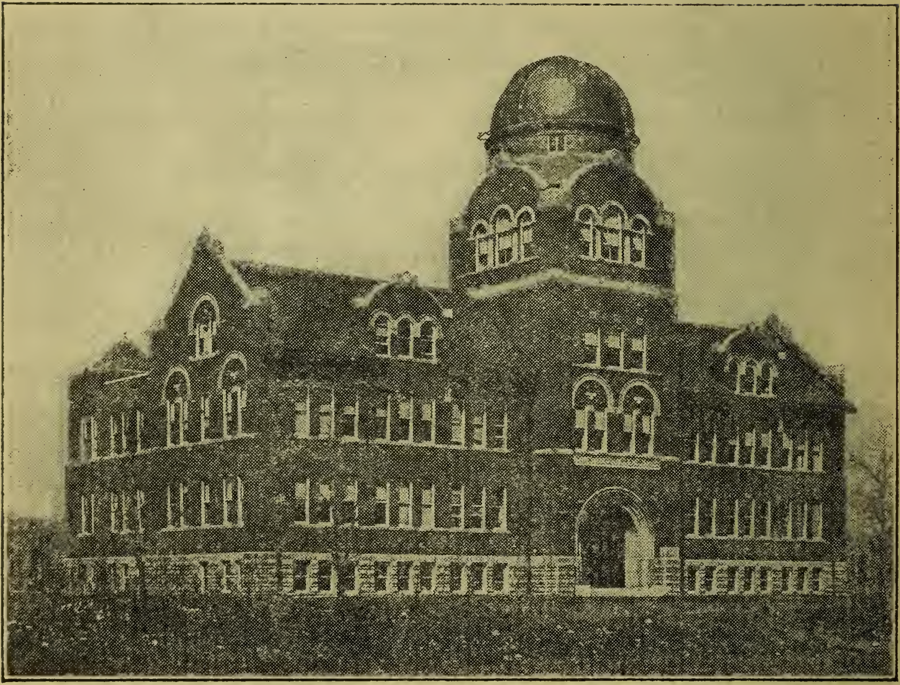
REGISTER OF STUDENTS.

FRESHMEN.

Robert J. Bailey	Oak Park, Ill.
Henry J. A. Cremer	Chicago, Ill.
John P. Duhig	Chicago, Ill.
Henry Eifler	Chicago, Ill.
Roy Goppelsroeder	Chicago, Ill.
D. Adrian Hunter	Elgin, Ill.
Cornelius W. Koebele	Chicago Heights, Ill.
Charles O. A. Kramer	St. Louis, Mo.
Harold McCaughey	Chicago, Ill.
Joseph J. Maucini	Chicago, Ill.
Louis C. Rockett, A. B	Cicero, Ill.
Nicholas A. Saigh	Chicago, Ill.
Arthur J. Schmitt	Chicago, Ill.
Elmer J. Spiegel, A. B	Chicago, Ill.

SPECIAL STUDENTS.

William Biedefeldt	Chicago, Ill.
Thomas S. Deegan	Chicago, Ill.
Rudolph Dusek	Chicago, Ill.
Timothy Hanrahan	Chicago, Ill.
Leo Harkins	Chicago, Ill.
James Higgins	Chicago, Ill.
George McDonough	Chicago, Ill.
Anthony Meyer	Chicago, Ill.
Clement J. Murphy	Chicago, Ill.
Aloysius Walsh	Chicago, Ill.



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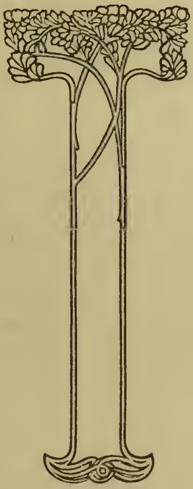
Department *of* Engineering



Bulletin—1913-1914

UNIVERSITY OF ILLINOIS
OCT 14 1914
PRESIDENT'S OFFICE

Loyola University 1913
Engineering

LOYOLA UNIVERSITY

Department *of* Engineering

Bulletin

1913-1914

Address: The Registrar or the Dean
Loyola Avenue and Sheridan Road, Chicago, Illinois
Telephone Rogers Park 620

OFFICERS AND FACULTY

John L. Mathery, S. J., President of the University.

Henry S. Spalding, S. J., Regent.

Adolph Anton Neff, B. S., M. E., Dean.

Paul Breen, S. J., Treasurer.

W. M. Conway, B. S., C. E., Professor of Civil Engineering.

Adolph Anton Neff, B. S., M. E., Professor of Mechanical Engineering.

James Guerin, A. B., B. S., Assistant Professor of Drawing.

John K. Moore, A. M., Lecturer on Construction.

Michael Joseph Milmoe, M. E., Lecturer on Machine Design.

Paul V. Hyland, Lecturer on Architecture and Building Construction.

Louis J. Puhl, S. J., Professor of Chemistry.

Thomas A. Kelly, S. J., Professor of Mathematics.

Frederic Siedenburg, S. J., Professor of Economics and English.

Philip Froebes, S. J., Professor of German.

William H. Cahill, A. M., C. E., Civil Engineering.

Ernest McCullough, C. E., Consulting Engineer, Chicago, Ill.

Arnold D. McMahon, A. M., L.L. B., Secretary and Professor, Loyola University Law School.

William Stetson Merrill, A. M., Chief Cataloger, Newberry Library, Chicago, Ill.

G. Leo Pleins, Consulting Sanitary Engineer, Chicago, Ill.

CALENDAR

First Semester, 1913-14.

1913.

Sept. 27	Entrance and conditional examinations.
Sept. 29	Registration days.
Sept. 30	Instruction begun.
Oct. 12	Columbus Day. (Holiday.)
Nov. 28	Thanksgiving recess begun.
Dec. 23	Christmas vacation begins.

1914.

Jan. 3	Instruction resumed.
Jan. 28-30	Final examinations of First Semester.

Second Semester, 1913-14.

Jan. 31	Registration day.
Feb. 3	Instruction begun.
Feb. 22	Washington's Birthday. (Holiday.)
May 28	Final examinations begun.
May 30	Memorial Day. (Holiday.)
June 2-28	Field work in Surveying.
June 21	Commencement.

First Semester, 1914-15.

1914.

Sept. 24	Entrance and conditional examinations.
Sept. 28	Registration days.
Sept. 29	Instruction begun.
Oct. 12	Columbus Day. (Holiday.)
Nov. 26	Thanksgiving recess begun.
Dec. 23	Christmas vacation begins.

REQUIREMENTS FOR ADMISSION.

Candidates for admission to the College of Engineering must be at least sixteen years of age, must present satisfactory testimonial of good moral character, and must be qualified in fifteen units of entrance subjects as enumerated below.

Note.—A unit represents the equivalent of five prepared recitations a week for one scholastic year in a single subject.

The prescribed units are:

English	3 units
History	1 unit
Elementary Algebra	1 unit
Advanced Algebra	½ unit
Plane Geometry	1 unit
Solid Geometry	½ unit
Elementary Physics	1 unit
Total	8 units

Electives sufficient to make up the required fifteen units may be offered from the following list:

Latin	2 to 4 units
Greek	1 to 3 units
German	2 to 3 units
French	2 to 3 units
English	1 to 2 units
History	1 to 2 units
Higher Algebra	½ unit
Plane Trigonometry	½ unit
Elementary Chemistry	1 unit
Biological Science	1 to 2 units
Manual Training	2 units

Admission may be secured in one of the following ways:

1. By Examination.—Entrance examinations will be held at the university in June and September. See Calendar.

2. By Certificate.—Graduates from standard high schools or other approved preparatory schools will be admitted on presentation of official certificates exhibiting the number of merits to which the applicant is entitled in each subject of the preparatory course pursued.

3. From Other Colleges.—Students from other institutions, whose entrance requirements and courses are substantially equivalent to those of Loyola University, will, upon presenting proper certificates of good standing and honorable dismissal, be admitted to advanced standing without examination and be given credit for the work done in such institutions.

4. As Special Students.—Persons over 19 years of age, not candidates for degrees, will be admitted as special students, provided they give evidence of preparation for the subjects desired. Such students may become candidates for degrees by passing the examinations prescribed for entrance.

FEES AND EXPENSES.

Matriculation fee	$ 5.00
Tuition	100.00
Diploma fee	10.00
Engineering laboratories, per credit, per semester	2.50
Physical and chemical laboratories, per credit, per semester	2.50
Surveying, field work, per semester	3.00
Summer course in surveying, 2 weeks	12.50
Summer course in surveying, 4 weeks	25.00
Breakage deposit (Chemistry)	10.00

The matriculation fee is paid only once. The tuition fee is payable in two installments: $50.00 on October 1st and $50.00 on February 1st; ten days of grace are allowed. At the end of that time non-payment debars from classes.

No rebate is allowed on tuition paid, but when a student is forced, for valid reasons, to withdraw from college, the balance of the tuition representing that part of the semester for which he is absent may be redeemed in any other department studies within one year from date of withdrawal from the college.

Any balance remaining at the end of each year from the deposit required to defray the expense of breakage in the chemical laboratories will be refunded or credited for the succeeding year at the option of the student.

The college provides no dormitory system for students. Board and rooms may be obtained in the vicinity of the college at reasonable rates.

Further information may be obtained from the Registrar or the Dean of the College of Engineering.

THE COURSES OF STUDY

The outlines of the courses which follow, and the formulation of their requirements, rest on the well founded theory that successful endeavor in any field of engineering activity depends primarily on thorough theoretical and practical training in the fundamental sciences on which modern engineering practice is based. To give such training as may lead to future usefulness on the part of its students, and to develop in them the power to attack and solve new engineering and scientific problems, is the purpose of the instruction offered in the College of Engineering. The work, therefore, in all the courses outlined, is mostly prescribed, and, because of the correlation and interdependence of the professions for which training is provided, a large proportion of the studies—modified in form and extent to meet the general requirements of the individual courses—are taken in common by all students.

Contemporary engineering practice has assumed many phases of specialization within the rather comprehensive fields of civil, mechanical, electrical, and chemical engineering in the general acceptation of the terms. No one may hope to become expert in more than a very few of the various lines classified under one or another of these broad divisions. Though specialized practice is the order of the day, it is very generally recognized that extreme latitude in the election of special technical studies, in connection with the courses offered, is not conducive to sound engineering education, and tends to defeat the real purpose of engineering training. There are therefore included as elective only a comparatively small number of such special technical subjects as are admittedly valuable in affording desirable general scientific training and promoting immediate average efficiency along broad lines of professional activity.

Note: Courses in Sanitary and Architectural Engineering are in preparation.

Considerable importance is attached to English, German, French, Logic, and Economics, which are included as prescribed studies and designed to accord with the other work of the courses. The requirement in English will not be considered satisfied by the completion of the work of the first year. Instruction will be resumed and continued for as long a period as may seem necessary in the case of any student who shows subsequent inability to express himself clearly, accurately, and effectively.

Frequent visits of inspection, according to prearranged schedule under the guidance of instructors, will be made to convenient manufacturing and industrial establishments, power plants, public works, the sites of important pieces of construction, and other points affording opportunities for stimulating the student's interest and increasing his knowledge. Such visits, besides familiarizing him in a general way with the significance of productive and constructive engineering and lending themselves to his acquirement of exact habits of observation, will afford a basis for written work in which rhetorical and technical instruction may be advantageously combined.

In line with the foregoing, the work in all the courses is identical during the first year, and there is little divergence during the second year. The student is thus afforded an opportunity for self-adjustment, and the danger of premature choice of profession, which is a factor to be reckoned with, is decreased; but he will have become habituated to the scientific methods of thought and procedure so important in the prosecution of his further studies. In the third year the differentiation between the courses, not only as contributory and essential to professional tively advanced and more highly specialized work of the fourth year there is permitted the election of one of a number of groups of studies bearing on some specialty closely related to the course hitherto pursued. All such elections presuppose thorough qualifying preparation, and are subject to the approval of the Dean. The major emphasis, however, is laid on the prescribed studies in all the courses is more specific, and in connection with the compara- success, but as desirable elements in culture and in life.

OUTLINE OF COURSES

FRESHMEN YEAR—COMMON TO ALL COURSES.

	First Semester.	Second Semester.
English	3	3
Logic	2	0
German or French	4	4
Chemistry	3	3
Drawing and Descriptive Geometry	3	3
Advanced Algebra	3	0
Trigonometry	3	0
Analytical Geometry	0	5
Elementary Surveying	0	3
	21	21

Surveying	2 weeks
Shop work	8 weeks

CIVIL ENGINEERING

SOPHOMORE YEAR.

Physics	5	5
Calculus	5	3
Differential Equations	0	2
Analytical Chemistry	3	0
Drawing	3	2
Geology	3	0
Economics	2	0
Advanced Surveying	0	4
Technical Mechanics	0	5
	21	21

Topographic Surveying	4 weeks
Shop or field work	6 weeks

JUNIOR YEAR.

Mechanics of Materials	5	0
Hydraulics	0	5
Materials Laboratory	2	2
Hydraulic Laboratory	0	1
Descriptive Astronomy	3	0
Geodesy	0	3
Roofs and Bridges	5	4
Railway Engineering	4	4
Roads and Pavements	2	0
Economics	0	2
	21	21

Railway Surveying (optional)	4 weeks
Shop, field, or office work	5 or 10 weeks

SENIOR YEAR.

	First Semester.	Second Semester.
Bridge Design	3	0
Water Supply	3	0
Sewerage	3	0
Heat-Power Machinery	3	0
Electrical Machinery	0	3
Mechanical and Electrical Laboratory	1	1
Reinforced Concrete	0	5
Masonry and Foundations	0	2
Engineering Problems	0	2
Economics	3	0
Contracts and Specifications	0	3
Elective	5	5
	21	21

MECHANICAL AND ELECTRICAL ENGINEERING

SOPHOMORE YEAR.

Physics	5	5
Calculus	5	3
Differential Equations	0	2
Analytical Chemistry	3	0
Machine Drawing	3	0
Geology	3	0
Economics	2	0
Kinematics	0	6
Technical Mechanics	0	5
	21	21

Shop work....................................10 weeks

JUNIOR YEAR.

Mechanics of Materials	5	0
Hydraulics	0	5
Materials Laboratory	2	1
Hydraulic Laboratory	0	1
Physical Laboratory	2	2
Heat-Power Engineering	3	3
Mechanical Laboratory	1	1
Electrical Machinery	3	3
Machine Design	5	3
Economics	0	2
	21	21

Shop work....................................10 weeks

SENIOR YEAR. (MECHANICAL.)

	First Semester.	Second Semester.
Power Plant Design	3	3
Steam Machinery Design	3	0
Gas Machinery Design	0	3
Designing and Drawing	3	3
Mechanical Laboratory	3	3
Electrical Laboratory	3	0
Economics	3	0
Contracts and Specifications	0	3
Elective	3	6
	21	21

SENIOR YEAR. (ELECTRICAL.)

Power Plant Design	3	3
Electrical Engineering	6	6
Mechanical Laboratory	3	0
Electrical Laboratory	3	3
Economics	3	0
Contracts and Specifications	0	3
Elective	3	6
	21	21

CHEMICAL ENGINEERING

SOPHOMORE YEAR.

Physics	5	5
Calculus	5	3
Differential Equations	0	2
Qualitative and Quantitative Chemistry	3	3
Drawing	3	0
Geology	3	0
Economics	2	0
Kinematics	0	3
Technical Mechanics	0	5
	21	21

Shop work.....10 weeks

JUNIOR YEAR.

Mechanics of Materials	3	0
Hydraulics	0	3
Materials Laboratory	2	1
Hydraulic Laboratory	0	1
Physical Laboratory	2	2

Quantitative Analysis	5	0
Organic Chemistry	5	5
Heat-Power Engineering	3	3
Mechanical Laboratory	1	1
Gas and Oil Analysis	0	3
Economics	0	2
	21	21

Shop or Laboratory Work........................10 weeks

SENIOR YEAR.

Industrial Chemistry	5	5
Physical Chemistry	2	2
Electro-Chemistry	2	2
Electrical Machinery	3	3
Economics	3	0
Contracts and Specifications	0	3
Elective	6	6
	21	21

DESCRIPTION OF COURSES

ENGLISH.

The object of the instruction is to enable the student to express himself clearly, concisely, accurately, and vigorously, special stress being laid on those parts of rhetoric which will be of greatest value to engineering students. The written exercises are designed to accord with the other work of the courses. Students are instructed in the use of the library collections.

1. A course in rhetorical theory and practice, with essays based on the lives of distinguished scientists and visits of inspection.

Freshman; 1st semester; 3 credits.

2. A continuation of course 1, with essays based on assigned technical readings and visits of inspection.

Freshman; 2nd semester; 3 credits.

3. A conditional course supplementing the work of 1 and 2, and consisting wholly of theme work and consultation.

Required only of students who show inability to write clear and correct English. It will be continued until a satisfactory degree of proficiency is attained.

FRENCH AND GERMAN.

All students are required to take one year of work in either French or German. Elementary and advanced courses will be offered in each and the student may elect either. For outlines and descriptions of these courses see Bulletin of the College of Arts and Sciences.

MATHEMATICS.

1. Advanced Algebra.—A brief review of the foundations with graphic representation and of the theory and use of logarithms, followed by a treatment of permutations and combinations, theory of limits, series, undetermined coefficients, determinants, theory of equations, complex numbers.

Freshman; 1st semester; 3 credits.

2. Trigonometry.—The trigonometric functions and their relations; proofs of the principal formulas of plane trigonometry; proofs of formulas and solution of all cases of right and oblique plane triangles; computation of areas.

Proofs of principal formulas of spherical trigonometry; formulas and solutions for right and oblique spherical triangles.

Freshman; 1st semester; 3 credits.

Numerous dependent problems and applications.

3. Analytic Geometry.—Graphic representation; the straight line; conic sections; higher plane curves; the essentials of Solid Analytic Geometry. Considerable problem work is required.

Freshman; 2nd semester; 5 credits.

4. Differential and Integral Calculus.—The direct and inverse operations are carried on in parallel. The fundamental formulas and methods of differentiating and integrating are followed by a geometric treatment of maxima and minima; applications to curves, surfaces, and volumes are considered. Taylor's Theorem and the subject of series in general will be treated in the second semester, together with the applications of the calculus to the engineering sciences. Some attention will be given to the subjects of Hyperbolic and Elliptic functions. Considerable problem work is exacted.

Sophomore; 1st semester, 5 credits; 2nd semester, 3 credits.

5. Differential Equations.—The purpose of the course, which is supplementary to course 4, is to familiarize the student with the types of equations ordinarily encountered in the study of the engineering sciences, and to indicate the principles and methods employed in their solution. The solution of numerous problems will be made a leading feature of this course.

Sophomore; 2nd semester, on completion of course 4; 2 credits.

ASTRONOMY.

1. Descriptive Astronomy.—A study of the fundamental facts and principles of the subject, with observatory practice.

Junior; 1st semester; 3 credits.

GEOLOGY.

1. General Geology.—A presentation of the general principles of geology and their practical applications. The course will be arranged with special reference to the needs of engineering students. Occasional excursions will replace laboratory practice. Three lectures and one laboratory period per week.

Sophomore; 1st semester; 3 credits.

ECONOMICS.

1. Elements of Economics.—A general survey of economic theory and a discussion of present-day economic problems including wages, rent, interest, currency, banking, taxation, tariff, trusts, trades-unionism, socialism. Lectures and classroom discussions.

Sophomore; 2nd semester; 2 credits.

2. Organization and Management.—A study of American industries and a discussion of the methods of organizing, financing, and managing modern commercial institutions. The purpose of the course is to acquaint the student with the application of the general principles of economics to business life. Lectures, discussions, and field work.

Junior; 1st semester; 3 credits.

PHILOSOPHY.

1. Logic.—Formal logic or dialectics; definition, material and formal elements, kinds of reasoning, how to build an argument, analytic and synthetic methods. Material logic: truth, its nature and kinds, certitude, skepticism, cognoscitive faculties, authority, etc.

Freshman; 1st semester; 2 credits.

2. Psychology and Ethics.—Nature and properties of the human soul, cognoscitive faculties, intellect, will, liberty. General ethics, human action, morality, form of human action, divine and human laws. Applied ethics, rights and duties, right of property, socialism, society, law, etc.

PHYSICS.

1. General Physics.—A general course in the subjects of Mechanics and Heat; Light and Sound; Electricity and Magnetism. The methods of the calculus are employed to a considerable degree. Two lecture-demonstrations, two recitations, and two laboratory periods per week.

Sophomore; throughout the year; 5 credits per semester.

2. Physical Measurements.—A laboratory course, supplemented by twelve lectures on the theory and methods of precise thermal and electrical measurements, involving quantitative work in the use of various instruments of precision, and the determination of physical constants. A report of specified form is required on each experiment.

Junior; throughout the year; 2 credits per semester.

3. Practical Photography.—The principles and processes of dry plate photography, including lectures on photographic optics and laboratory work in the exposure and development of dry plates; printing processes, copying, enlarging, and the making of lantern slides.

Elective; second semester; 2 credits.

DRAWING AND DESCRIPTIVE GEOMETRY.

Note.—The freshman work in drawing and descriptive geometry is given as a combined course, but, in the cases of special students or of those admitted to advanced standing, separate courses may be given as follows:

1. Elements of Drawing.—Freehand lettering; sketching and dimensioning; geometrical construction; orthographic projection and isometric drawing; working drawings, including conventions, standards, etc.; tracing and reproductive processes. Notes and lectures on drafting room methods.

Freshmen; 1st semester; 3 credits.

2. Descriptive Geometry.—The descriptive geometry of points, lines, planes, surfaces, and solids. Tangencies, intersections, and developments. Shades and shadows and the principles of linear perspective. One lecture or recitation and two drafting periods a week.

Freshmen; 2nd semester; 3 credits.

MECHANICS AND HYDRAULICS.

1. Technical Mechanics.—The principles of Statics, Kinematics, and Kinetics, with technical applications. Analytic and graphic methods are used concurrently in the solution of problems.

Sophomore; 2nd semester; 5 credits.

2. Mechanics of Materials.—A study of the more important materials of construction, their manufacture, properties, and structural uses, and the theory of resistance to stress and deformation with applications to engineering design. Lectures and recitations.

Junior; 1st semester; 5 credits.

2a. Mechanics of Materials.—A briefer course than 2; arranged to meet the requirements in Chemical Engineering.

Junior; 1st semester; 3 credits.

3. Advanced Mechanics.—An advanced course supplementary to 2, and devoted to the treatment of such special topics as dynamical stability, the mathematical theory of elasticity, internal work and its derivatives, the theorem of least work, linear arches and curved beams. Lectures, problems, and applications.

Senior elective; 1st semester; 3 credits.

4. Materials Laboratory.—The laboratory practice will be adapted to the requirements of the individual courses and will include the various standard tests of the more important materials of construction. The work will be supplemented by lectures on the technique of testing, collateral reading, and reports carefully prepared according to a prescribed form.

Junior; throughout the year; 2 credits per semester.

4a. Materials Laboratory.—An advanced laboratory course, in continuation of the work of 4, devoted to testing and special investigations of materials of construction. Hours and nature of experimental work to be assigned in conference with the instructors concerned.

Senior elective; 1 to 3 credits per semester.

5. Hydraulics.—The theory of fluid pressure and equilibrium; the flow of water through orifices, weirs, tubes, pipes and channels, the theory of hydraulic measurements; hydraulic motors and machinery; naval hydromechanics. Lectures and recitations.
Junior; 2nd semester; 5 credits.

5a. A briefer course than 5, adapted to meet the requirement in Chemical Engineering.
Junior; 2nd semester; 3 credits.

6. Hydraulic Laboratory.—An experimental course to accompany 5, including logarithmic plotting, experiments with weirs, orifices, pipes, meters and nozzles; the testing of hydraulic machinery.
Junior; 2nd semester; 1 credit.

6a. Hydraulic Laboratory.—An advanced course in experimental hydraulics, including capacity and efficiency tests of hydraulic machinery. The hours of work will be by appointment, and some latitude will be allowed as to the nature of the experimentation.
Senior elective; either semester; 1 to 3 credits.

CIVIL ENGINEERING.

1. Elementary Surveying.—Lectures, recitations, field and office work covering the principles, uses, and adjustments of the engineer's level and transit, and the uses of the steel tape; topographic surveying with transit and stadia.
Freshmen; 2nd semester; 3 credits.

2. Advanced Surveying.—The application of the fundamental operations to city, land, mine, and hydrographic surveying; the use of the plane table and sextant; precise leveling and triangulation; including the measurement of base lines and angles; the determination of azimuth by solar observation. Lectures, recitations, field and office work.
Sophomore; 2nd semester; 4 credits.

3. Geodesy.—The principles of practical astronomy and their application in the determination of latitude, longitude, time, and azimuth with the engineer's transit and sextant. Methods of conducting geodetic surveys, and the application of the method of least squares to the adjustment of observations. The figure of the earth.
Junior; 2nd semester; 3 credits.

4. Summer Surveying.—The Summer courses in surveying are given at the close of the school year in June and are of a practical nature. The student will spend ten hours a day in the field or office in the performance of the various duties incident to the work of the surveyor. The courses in Elementary and Topographic Surveying are prescribed. The course in Railway Surveying and Location is optional. The periods allotted to these

courses are two weeks for Elementary Surveying, and four weeks each for Topographic and Railway Surveying.

5. Topographic Drawing.—The conventional methods of representing topography and the platting of the results of surveys.
Sophomore; 2nd semester; 2 credits.

6. Construction Drawing.—Stereotomy, dams, piers, arches, trestles, culverts, etc. Applications of Descriptive Geometry to engineering construction.
Sophomore; 1st semester; 3 credits.

7. Railway Engineering.—Lectures, recitations, field, and office work dealing with the subjects of railway location and construction. The theory of simple, compound, and transition curves, cross-overs, frogs and switches, turnouts, etc. Cross sectioning, the computation of cut, fill and haul; road bed construction, including ballast, track, culverts, trestles, etc. Estimates and costs.

The economics of location embracing a treatment of such topics as train resistance, the influence of grade, curvature, rise and fall; rolling stock and motive power; yards, stations, and terminals; street railways.
Junior; throughout the year; 4 credits per semester.

8. Railway Engineering.—A continuation of course 7, including a discussion of the economics of construction, a study of organization and management, maintenance of way, etc.
Senior elective; throughout the year; 2 credits per semester.

9. Railway Designs.—A conference and drawing room course in the proportioning of culverts and waterways, and the design of track layouts, yards, terminals, bridge masonry, and other railway structures.
Senior elective; 2nd semester; 3 credits.

10. Roads and Pavements.—The location, construction, and maintenance of roads, and the construction and maintenance of city streets and pavements, combined with a study of the materials used. Lectures, recitations, and collateral reading; visits of inspection and reports.
Junior; 1st semester; 2 credits.

11. Roofs and Bridges.—The analytic and graphic investigation of stresses in framed structures under various conditions of loading. Structural details. The design of a metal roof truss and of a plate girder, including general and detail drawings, bills of material, weights, and costs.
Junior; throughout the year; 1st semester; 5 credits; 2nd semester, 4 credits.

12. Bridge Design.—A continuation of course 11, involving the drafting room application of its principles to the design of simple riveted and

pin-connected truss spans, following the practice of leading bridge companies.

Senior; 1st semester; 3 credits.

13. Higher Structures.—A study of continuous, cantilever, suspension, and arch bridges; statically indeterminate structures. Lectures, computations, and drafting room work.

Senior elective; throughout the year; 3 credits per semester.

14. Steel Buildings.—The principles of construction of mill and high steel-skeleton buildings; computation of stresses and design.

Senior elective; either semester; 2 credits.

15. Reinforced Concrete.—The theory and design of beams, slabs, columns, retaining walls, dams, and other structures, and a critical study of the design and structural features of reinforced concrete arch types. The course is concluded by the complete design, including drawings, of a reinforced concrete arch.

Senior; 2nd semester; 5 credits.

16. Masonry and Foundations.—The course is given by lectures, recitations, collateral reading, and visits of inspection. Among the subjects treated are the materials of masonry; the construction of bridge piers, abutments, dams, retaining walls, etc.; ordinary, pile, and subaqueous foundations.

Senior; 2nd semester; 2 credits.

17. Water Supply.—The collection, purification, and distribution of water supplies for domestic and other purposes.

Senior; 1st semester; 3 credits.

18. Sewerage.—The collection, treatment, and disposal of sewage. Lectures, recitations, and inspection trips.

Senior; 2nd semester; 3 credits.

19. Sanitary Engineering.—A continuation of 18 and 19, the work being devoted principally to problems and designing related to water supply, sewer systems, and sewage disposal plants.

Senior elective; 2nd semester; 5 credits.

20. Hydraulic Engineering.—The application of hydraulic theory and principles to the investigation and development of water power; irrigation, river and harbor improvement; drainage and canalization. The design of hydraulic works, plants, and appliances.

Senior elective; throughout the year; 3 credits per semester.

21. Engineering Problems.—The application of fundamental principles to the investigation and solution of practical problems.

Senior; 2nd semester; 2 credits.

22. Contracts and Specifications.—The elements of business law and a survey of the law of contracts as applied to engineering work. A study of general and special clauses used in the various kinds of engineering specifications. Practice in the preparation of contracts and specifications.

Senior; 2nd semester; 3 credits.

MECHANICAL ENGINEERING.

1. Machine Drawing.—A continuation of Drawings 1 and 2, and the application of their principles to machine drawing and empirical design. Sketching and detailing machine elements from model and copy; the making and use of standard data sheets; detail assembly drawings of complete machines. The work is designed to familiarize the student with commercial drafting room practice, and is of distinctly vocational character.

Sophomore; 1st semester; 3 credits.

2. Kinematics of Machinery.—Lectures and recitations on the theory of mechanisms, instant centers, cams, gears, linkage, velocity and acceleration diagrams, etc.

Sophomore; 2nd semester; 3 credits.

3. Kinematic Drawing.—The graphic application of the principles of course 2. A series of separate problems of graded complexity will be assigned to each student.

Sophomore; 2nd semester; 3 credits.

3a. Kinematics.—A combined lecture, recitation, and drafting room course briefer than 2 and 3, and arranged to satisfy the requirement in the principles of mechanism for chemical engineering students.

Sophomore; 2nd semester; 3 credits.

4. Lectures, recitation, and drafting room exercises covering the application of the principles of Drawing, Kinematics, and Mechanics to the proportioning of machine elements and the designs of complete machines.

Junior; throughout the year: 1st semester, 5 credits; 2nd semester, 3 credits.

5. Heat-Power Engineering.—Lectures and recitations on the thermodynamics of gases and vapors as applied to heat engines; a study of fuels and the principles of combustion; boilers, engines, and auxiliaries. The indicator diagram. A detailed analysis of efficiencies and economies of various types of steam engines, gas engines, and turbines; valves and valve gears.

Junior; throughout the year; 3 credits per semester.

5a. Heat-Power Machinery.—A lecture and recitation course for civil engineering students, designed to impart a general knowledge of the structural features and operating characteristics of boilers and producers, steam and gas engines and auxiliaries, pumping, hoisting, traction, and other machinery. The course is devoid of much technical detail.

Senior; 1st semester; 3 credits.

6. Mechanical Laboratory.—Introductory experimental work in the testing and calibration of gauges, indicators, integrating instruments, etc.; power measurements; fuel and gas analysis; oil testing; the determination of engine efficiencies and the testing of auxiliary apparatus.

Junior; throughout the year; 1 credit per semester.

6a. Mechanical Laboratory.—A continuation of course 6, the work including the testing and determination of efficiencies of steam engines, boilers, gas and oil engines, pumps, air compressors, refrigerating machinery, etc.

Senior; throughout the year; 3 credits per semester.

6b. Mechanical Laboratory.—An advanced experimental course open only to students who have completed the prescribed laboratory courses. Hours and nature of the work to be arranged.

Elective; either semester; 1 to 3 credits.

Note.—The work in experimental engineering is varied according to the courses. Each experiment will be followed by a carefully prepared report of specified form.

7. Power Plant Design.—A continuation of course 5. Lectures, recitations, and computations dealing with the types and principles of boilers; multiple expansion engines, and their auxiliaries and dependencies; gas engines; steam turbines, refrigerating machinery, and air compressors. The selection of elements and their combination in power plants.

Senior; throughout the year; 3 credits per semester.

8. Steam Machinery Design.—A study of types and proportions of steam engines; the indicator card; entropy—temperature and crank effort diagrams; the design of such details as valve gears, governors, and flywheels; the balancing of engines.

Senior; 1st semester; 3 credits.

9. Gas Machinery Design.—A study of modern gas engines and producers, and the designing of important details of internal combustion engines.

Senior; 2nd semester; 3 credits.

10. Designing and Drawing.—A drafting room course paralleling the work of 8 and 9. This course must be accompanied, or preceded by 8 and 9.

Senior; throughout the year; 3 credits per semester.

11. Steam Boilers.—A study of steam boiler types, fuels and furnaces; steam boiler computations, and the design of boiler details and accessories.
Senior elective; 1st semester; 3 credits.

12. Steam Turbines.—A general discussion of the types, principles, and economic and structural features of steam turbines; steam turbine calculations.
Senior elective; 2nd semester; 3 credits.

13. Compressed Air.—A study of the properties of air, the principles of air compressors, and the applications of compressed air.
Elective; 2nd semester; 2 credits.

14. Heating and Ventilation.—The fundamental principles of the subject, and their application to the design, construction, and installation of heating and ventilating systems.
Senior elective; 2nd semester; 2 credits.

15. Mechanical Refrigeration.—A study of the principles and methods involved in the artificial production of low temperatures, and a survey of the design, construction, and operation of refrigerating machinery and refrigerating systems.
Senior elective; 2nd semester; 2 credits.

ELECTRICAL ENGINEERING.

1. Electrical Machinery.—Lectures, recitations, and laboratory work dealing with the history of the subject, and the laws and properties of electric and magnetic circuits; electrical measurements; the theory construction and operation of direct and alternating current machinery.
Junior; throughout the year; 3 credits per semester.

1a. Electrical Machinery.—A briefer course than 1, arranged to meet the needs of civil engineering students.
Senior; 2nd semester; 3 credits.

2. Electrical Engineering.—Lectures, recitations, and computations on the theory and characteristics of electrical machinery, dealing in detail with the laws and properties of electric and magnetic circuits; direct and alternating current phenomena; transmission lines; generators, motors, transformers, converters, etc.
Senior; throughout the year; 6 credits per semester.

3. Electrical Laboratory.—Practice in the electrical laboratories will be continuous throughout the junior and senior years. The work will be of such nature as to meet the requirements of the individual courses. Opportunities for laboratory work of an advanced character will be afforded

to those who have completed the prescribed courses. The regular work will include the testing of instruments, generators, motors, transformers, converters, storage batteries, etc.; it will be supplemented by occasional lectures. A carefully prepared report on each experiment is required.

Throughout the year; junior, 1 credit per semester; senior, 3 credits per semester.

4. TELEPHONE ENGINEERING.—The theory and operation of telephonic apparatus and the application of the principles of electrical engineering to the design, construction, and maintenance of transmission lines, and to the investigation of problems in telephone engineering.
Senior elective; 1st semester; 3 credits.

5. ELECTRIC RAILWAYS.—The application of the principles of electrical engineering to the construction, operation, and equipment of various types of electric railway systems. The dynamics of train movement, and the plotting of speed-time curves, railway load curves, etc.; location and financing; cost of construction and operation.
Senior elective; 2nd semester; 3 credits.

6. TRANSMISSION AND DISTRIBUTION OF ELECTRIC ENERGY.—A discussion of typical systems of power generation, transmission, and distribution for lighting, traction, and industrial purposes, and their design, construction, operation, and maintenance with some reference to costs and rates.
Senior elective; 2nd semester; 3 credits.

7. DESIGN OF ELECTRICAL MACHINERY.—The applications of fundamental principles and of considerations of commercial practice to the design of various classes of direct and alternating current machinery.
Senior elective; 2nd semester; 3 credits.

8. ILLUMINATION AND PHOTOMETRY.—The theory of illumination and a discussion of illuminating apparatus and devices; the design, construction, and operation of electric lighting systems and the photometry of lamps.
Senior elective; 2nd semester; 3 credits.

CHEMISTRY AND CHEMICAL ENGINEERING.

1. GENERAL CHEMISTRY.—Entrance Chemistry, if offered, will not be accepted as the equivalent of this course.

Two lecture-demonstrations, one recitation, and one laboratory period, covering the fundamental principles of the science, the chemistry of the non-metals, and metals and the elements of qualitative chemical analysis.
Freshmen; throughout the year; 3 credits.

2. QUALITATIVE ANALYSIS.—The laboratory work will be varied to some extent according to the course pursued and will include analyses of alloys, rocks, minerals, slags, mattes, and other compounds or mixtures. One lecture or recitation and three laboratory periods per week.

Sophomore; 2nd semester; 3 credits.

3. QUANTITATIVE ANALYSIS.—An introductory course consisting of one lecture and three laboratory periods per week devoted to volumetric and gravimetric determinations, including practice in the calibration of flasks and burettes, acidimetry and alkalimetry, chlorimetry, and the analysis of simple compounds and ores.

Sophomore; 2nd semester; 3 credits.

4. QUANTITATIVE ANALYSIS.—A continuation of course 3, and of a more advanced nature. Instruction will be given gravimetric, volumetric, and electrolytic methods of analysis. The work will include the analyses of iron and steel, slags, silivates, paints, lubricants, ores, etc. One lecture, laboratory conferences and the equivalent of five laboratory periods weekly.

Junior; 1st semester; 5 credits.

5. GAS AND OIL ANALYSIS.—A laboratory course with weekly conferences, devoted to practice in the calorimetry and typical methods of analysis of gases and oils.

Junior; 2nd semester; 3 credits.

6. WATER ANALYSIS.—Lectures and laboratory practice in the examination of water with reference to its use for domestic and industrial purposes.

Elective; 1st semester; 3 credits.

7. ORGANIC CHEMISTRY.—Two lectures and one recitation on the general principles and theories of organic chemistry and the methods of preparation and characteristic reactions of organic compounds with a corresponding laboratory course of three periods per week. A limited amount of work along special lines or organic chemistry may be elected.

Junior; throughout the year; 5 credits.

8. ADVANCED ORGANIC CHEMISTRY.—A conference and laboratory course dealing with the preparation and reactions of special classes of organic compounds and including ultimate organic analysis. The work may be varied, in a limited degree, according to the option of the student.

Senior elective; throughout the year; 3 to 4 credits per semester.

9. INDUSTRIAL CHEMISTRY.—The course is given by means of lectures, recitations, laboratory practice, and visits of inspection, and deals with the chemical processes, apparatus, and operations involved in various chemical

industries, and with the analysis of raw materials and products. Attention is given, as far as may be, to estimates of apparatus and plants for particular purposes and to costs and management.

Senior; throughout the year; 5 credits per semester.

10. PHYSICAL CHEMISTRY.—The course is arranged to embrace a systematic presentation, with experimental illustration, of the more important principles of theoretical chemistry, stress being laid on such points as the theory of solution, reaction velocity, catalysis, chemical equilibrium, and the applications of the principles of physical chemistry to industrial practice. The course is accompanied by laboratory work in the determination of molecular weights and physico-chemical measurements.

Senior; throughout the year; 2 credits per semester.

11. ELECTRO-CHEMISTRY.—Lectures, recitations, and laboratory work partly in continuation of course 11, dealing with the principles of the subject and their application to chemical industries. The laboratory practice includes electro-chemical measurements and the electrolysis of chemical compounds.

Senior; throughout the year; 2 credits per semester.

12. MICROCHEMISTRY.—Lectures and laboratory work on the use of the microscope and its accessories, and the application of microscopic apparatus and methods to chemical investigation and analysis.

Senior elective; 2nd semester; 3 credits.

13. ASSAYING.—Lectures and laboratory work in the crushing, sampling, and assaying of gold, silver, copper, lead, and zinc ores, and the sampling and assaying of bullion.

Elective; 1st semester; 3 credits.

14. METALLURGY OF IRON AND STEEL.—A discussion of the properties and principles of production and manufacture of iron and steel, with laboratory practice in special analytical methods applicable to iron and steel determinations. The work is supplemented by visits of inspection and reports.

Senior; 1st semester; 2 or 3 credits.

15. GENERAL METALLURGY.—A course treating of metallurgical processes and the principles of combustion and thermochemistry, pyrometry, fuels, fluxes, refractories, furnaces and artificial draft and blast.

Senior elective; 1st semester; 2 credits.

16. METALLURGICAL PROBLEMS.—The solution of a number of selected problems relating to the principles utilized in practical metallurgy.

Senior elective; 1st semester; 1 to 2 credits.

17. Metallurgy of Non-ferrous Metals.—A course of lectures dealing in considerable detail with the metallurgy of copper, lead, silver, gold, zinc, and aluminum, and more briefly with nickel, cobalt, arsenic, antimony, tin, mercury, bismuth, etc. The physical and chemical properties of ores and the various processes employed and principles involved in reduction and refinement are discussed.

Senior elective; 2nd semester; 3 credits.

18. Metallurgical Laboratory.—The laboratory practice is closely related to the class room exercises. It includes special analytical methods applicable to iron and steel, fuel, fluxes, and slags. Practice in pyrometry and the measurement of blast velocity, and the analysis of flue gas by special apparatus. Roasting, smelting, leaching and amalgamating processes as applied to the reduction of the ores of gold, silver, copper and lead.

Senior; 2nd semester; 3 to 5 credits.

19. Chemical Engineering.—A study of the types of apparatus and operations involved in chemical manufacture, the design of chemical plants, and the consideration of the chemical resistance of materials suitable for their construction.

Senior elective; 2nd semester; 3 to 5 credits.

EXAMINATIONS

Examinations are held semi-annually at the end of each semester. The work done during the semester, as well as the examinations, is considered in the grading of students. The results of the examinations are expressed on the basis of 100.

70 is required for passing; 60-70 indicates a condition; below 60 shows failure. Regularity of attendance at lectures and laboratory, and faithfulness in the performance of daily work are of as much weight in determining the standing of students in their classes as are the examinations.

Conditions.—Conditioned students must remove such conditions at the examinations given for that purpose during the following semester. Failing in this the student is obliged to discontinue the subject in which he is conditioned and to repeat it during the next semester.

For a special examination of this kind a fee of $1.00 is charged.

DEGREES.

The degree of Bachelor of Science in Civil Engineering, Mechanical Engineering, Electrical Engineering, and Chemical Engineering will be conferred on students who satisfactorily complete the corresponding courses.

REGISTER OF STUDENTS—1912-1913

William Bielefeldt	Freshman
George M. Briody	Freshman
Lawrence Leo Conlon	Special
Robert M. Connelly	Freshman
John P. Duhig	Sophomore
Henry Eifler	Sophomore
Irvin J. Fernekas	Freshman
Felix Firley	Freshman
Roy Goppelsroeder	Sophomore
John A. Granzow	Freshman
Francisco Fernandez Grau	Freshman
Alfred Alphonse Holland	Freshman
Herbert W. Kelly	Freshman
Cornelius W. Koebele	Sophomore
J. H. McCaughey	Freshman
Joseph J. Maucini	Sophomore
Arthur C. Meyer	Sophomore
Manuel F. Montana	Freshman
Braulio A. Munecas	Freshman
J. Alphonse Rauen	Freshman
Louis C. Rockett	Sophomore
Nicholas A. Saigh	Sophomore
Howard F. Smith	Freshman
Elmer John Spiegel	Sophomore
Frank Joseph Stevens	Freshman
John Joseph Wagner	Sophomore
William Francis Waugh	Freshman

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